

WHAT IS CLAIMED IS:

1. A method of using olefins for making a surfactant selected from the group consisting of an anionic surfactant, a nonionic surfactant, and a cationic surfactant, said method comprising:

subjecting a paraffinic wax to first conditions effective to hydrocrack and hydroisomerize said paraffinic wax and to produce an isoparaffinic composition comprising 0.5% or less quaternary aliphatic carbon atoms, said isoparaffinic composition comprising paraffins having a carbon number of from about 7 to about 35, at least a portion of said paraffins being branched paraffins comprising an average number of branches per paraffin molecule of at least 0.7 calculated over the total of branched paraffins and linear paraffins present, said branches comprising a first number of methyl branches and optionally a second number of ethyl branches;

exposing said isoparaffinic composition to a dehydrogenation catalyst in an amount and under dehydrogenation conditions effective to dehydrogenate said isoparaffinic composition and to produce a branched olefin composition comprising 0.5% or less quaternary aliphatic carbon atoms; and

converting said branched olefin composition into said surfactant.

2. The method of claim 1 wherein said branches comprise said methyl branches and said ethyl branches.

3. The method of claim 1 wherein said surfactant is selected from the group consisting of branched alcohols and branched sulfonates.

4. The method of claim 1 wherein said branched olefins are fed to a hydroformylation catalyst under hydroformylation conditions effective to react said branched olefins with carbon monoxide and hydrogen, thereby producing branched alcohols.

5. The method of claim 4 wherein said hydroformylation catalyst comprises a metal selected from Group 8 of the Periodic Table of the Elements.

6. The method of claim 5 wherein said metal is selected from the group consisting of palladium, platinum, rhodium, nickel, and cobalt.

7. The method of claim 5 wherein said metal is selected from the group consisting of cobalt, rhodium and palladium.

8. The method of claim 5 wherein said metal further comprises at least one ligand selected from the group consisting of phosphine ligands, phosphite ligands, arsine ligands, stibine ligands, and pyridine ligands.

9. The method of claim 4 wherein said hydroformylation catalyst is selected from the group consisting of cobalt hydrocarbonyl catalysts, cobalt-phosphine ligand catalysts, and rhodium-phosphine ligand catalysts.

10. The method of claim 8 wherein said ligand is selected from the group consisting of phosphine, an arsine, and a stibine, and said ligand comprises three secondary ligands selected from the group consisting of hydrocarbyls, hydrocarbyloxy groups, and combinations thereof.

11. The method of claim 4 wherein said hydroformylation catalyst comprises bis- ligands selected from the group consisting of phosphine ligands, arsine ligands, and stibine ligands, said bis- ligands each comprising secondary ligands selected from the group

consisting of hydrocarbyls, hydrocarbyloxy groups, and combinations thereof.

12. The method of claim 4 wherein said hydroformylation catalyst is selected from the group consisting of triamylphosphine, trihexylphosphine, dimethylethylphosphine, diamylethylphosphine, tricyclopentylphosphine, tricyclohexylphosphine, diphenylbutylphosphine, diphenylbenzylphosphine, diphenyl(2-pyridyl)-phosphine, phenyl[bis(2-pyridyl)]phosphine, triethoxyphosphine, butyldiethoxyphosphine, triphenylphosphine, dimethylphenylphosphine, methylidiphenylphosphine, dimethylpropylphosphine, tritolylphosphines, 1,2-bis(dimethylphosphino)ethane, 1,2- and 1,3-bis(dimethylphosphino)propane, 1,2-bis(diethyl-phosphino)ethane, 1,2-bis[di(1-butyl)phosphino]ethane, 1-dimethylphosphino-2-diethylphosphinoethane, 1,2-bis(di-phenylphosphino)ethane, 1,2-bis(diperfluorophenyl-phosphino)ethane, 1,3-bis(diphenylphosphino)propane, 1,4-bis(diphenylphosphino)butane, 1-dimethylphosphino-2-diphenylphosphinoethane, 1-diethylphosphino-3-diphenyl-phosphinopropane, 1,2-bis[di(o-tolyl)phosphino]ethane, a phosphabicyclo-hydrocarbon, 9-hydrocarbyl-9-phospha-bicyclononane and  $P, P = -\text{bis}(9\text{-phosphabicyclonyl})$ -hydrocarbons in which the smallest  $P$ -containing ring contains at least 5 carbon atoms, 9-aryl-9-phosphabicyclo[4.2.1]nonanes, 9-(dialkylaryl)-9-phosphabicyclo[4.2.1]nonanes, 9-alkyl-9-phospha-bicyclo[4.2.1]nonanes, 9-cycloalkyl-9-phospha-bicyclo[4.2.1]nonanes, 9-cycloalkenyl-9-phosphabicyclo[4.2.1]nonanes,  $P, P = -\text{bis}(9\text{-phosphabicyclonyl})$ alkanes and their [3.3.1] isomers, 9-phenyl-9-phosphabicyclo[4.2.1]nonane, 9-(2,4-dimethylphenyl)-9-phosphabicyclo[4.2.1]nonane, 9-ethyl-9-phosphabicyclo[4.2.1]nonane, 9-cyclohexyl-9-phosphabicyclo[4.2.1]nonane, 9-cyclopentenyl-9-phospha-bicyclo[4.2.1]nonane,  $1,2-P, P = -\text{bis}(9\text{-}$

phosphabicyclo[4.2.1]nonyl)ethane, 1,3-P, P=-bis(9-  
phosphabicyclo[4.2.1]nonyl)propane, 1,4-P, P=-bis(9-  
phosphabicyclo-[4.2.1]nonyl)butane and their [3.3.1]  
isomers.

13. The method of claim 4 wherein said hydroformylation conditions comprise a temperature of from about 20 °C to about 300 °C and a pressure of from about 10 to about 200 bara.

14. The method of claim 4 wherein said hydrogen and said carbon monoxide are present at a molar ratio of greater than 1.

15. The method of claim 4 wherein said hydroformylation conditions comprise an inert solvent selected from the group consisting of ketones, aromatic compounds, halogenated paraffinic hydrocarbons, and saturated hydrocarbons.

16. The method of claim 1 wherein said surfactant is selected from the group consisting of a surfactant sulfate and a surfactant sulfonate.

17. The method of claim 1 wherein at least 75 %w of said branched paraffins represent a range of molecules of which the heaviest molecules comprise at most 6 carbon atoms more than the lightest molecules.

18. The method of claim 1 wherein a majority of said isoparaffinic composition comprises paraffins having a carbon number of from about 10 to about 18.

19. The method of claim 1 wherein at least 75 %w of said isoparaffinic composition comprises paraffins having a carbon number of from about 10 to about 18.

20. The method of claim 1 wherein at least 90 %w of said isoparaffinic composition comprises paraffins having a carbon number of from about 10 to about 18.

21. The method of claim 1 wherein said average number of branches is at most 2.5.

22. The method of claim 1 wherein said first number of methyl branches is at least 50%.

23. The method of claim 1 wherein said second number of ethyl branches is at most 10% of the total number of said branches.

24. The method of claim 1 wherein the number of any branches other than said methyl branches and said ethyl branches is 10% or less.

25. The method of claim 1 wherein the number of any branches other than said methyl and said ethyl branches, is 5% or less.

26. The method of claim 1 wherein said isoparaffinic composition comprises less than 0.3% quaternary aliphatic carbon atoms.

27. The method of claim 1 wherein said isoparaffinic composition comprises at least 70%w branched paraffins.

28. The method of claim 1 wherein said isoparaffinic composition comprises at least 90%w branched paraffins.

29. The method of claim 1 wherein said isoparaffinic composition comprises at most 5%w linear paraffins.

30. The method of claim 1 wherein said isoparaffinic composition comprises at most 1%w linear paraffins.

31. The method of claim 1 wherein said isoparaffinic composition comprises at most 0.1%w linear paraffins.

32. The method of claim 1 wherein said paraffinic wax originates from a source selected from the group consisting of crude oil distillation fractions and products of hydroisomerization of a paraffinic composition.

33. The method of claim 1 wherein said isoparaffinic composition originates from a source selected from the group consisting of a Fischer Tropsch synthesis and oligomerization of ethylenes.

34. The method of claim 1 wherein said isoparaffinic composition originates from a Fischer Tropsch synthesis.

35. The method of claim 1 wherein linear paraffins in said paraffinic wax consist essentially of linear paraffins having at least 5 carbon atoms.

36. The method of claim 1 wherein linear paraffins in said paraffinic wax consist essentially of linear paraffins having at least 15 carbon atoms.

37. The method of claim 1 wherein linear paraffins in said paraffinic wax consist essentially of linear paraffins having at least 25 carbon atoms.

38. The method of claim 1 wherein said isoparaffinic composition is exposed to an absorbent effective to reduce linear paraffin content.

39. The method of claim 38 wherein said absorbent comprises a zeolite.

40. The method of claim 39 wherein said zeolite is selected from the group consisting of zeolite 4A, zeolite 5A, zeolite X, zeolite Y, and a combination thereof.

41. The method of claim 1 wherein said dehydrogenation catalyst comprises a quantity and type of metal or metal compound effective to catalyze said dehydrogenation.

42. The method of claim 41 wherein said metal or metal compound is deposited on a porous support selected from carbonaceous porous supports, natural or synthetic clays or silicates, ceramics, refractory inorganic oxides, naturally or synthetic crystalline alumino-silicates, and combinations of two or more elements selected from these groups.

43. The method of claim 41 wherein said metal or metal compound is selected from the group consisting of chrome oxide, iron oxide, and noble metals.

44. The method of claim 41 wherein said metal or metal compound is a noble metal selected from the group consisting of platinum and palladium.

45. The method of claim 42 wherein said porous support comprises an alumina.

46. The method of claim 45 wherein said alumina is selected from the group consisting of a gamma alumina, eta alumina, and a combination thereof.

47. The method of claim 41 wherein said quantity of metal or metal compound is from about 0.01 to about 5 %w.

48. The method of claim 41 wherein said metal or metal compound is a noble metal and said dehydrogenation catalyst further comprises a second metal selected from the group consisting of Group 3a, Group 4a and Group 5a of the Periodic Table of the Elements.

49. The method of claim 41 wherein said metal or metal compound is a noble metal and said dehydrogenation catalyst further comprises one or more component selected from the group consisting of a halogen and a second metal selected from the group consisting of indium, tin, alkali, and alkaline earth metals.

50. The method of claim 49 wherein said second metal is an alkali metal selected from the group consisting of potassium and lithium.

51. The method of claim 49 wherein said second metal is tin.

52. The method of claim 49 wherein said halogen is chlorine.

53. The method of claim 49 wherein said quantity of said one or more component independently is from about 0.01 to 5 %w.

54. The method of claim 1 wherein said dehydrogenation catalyst is selected from the group consisting of chrome oxide on gamma alumina, platinum on gamma alumina, palladium on gamma alumina, platinum/lithium on gamma alumina, platinum/potassium on gamma alumina, platinum/tin on gamma alumina, platinum/tin on

40075582.0214232

hydrotalcite, platinum/indium on gamma alumina and platinum/bismuth on gamma alumina.

55. The method of claim 1 wherein said dehydrogenation conditions comprise a temperature of from about 300 °C to 700 °C and a pressure of from about 1.1 to about 15 bara.

56. The method of claim 1 wherein hydrogen and said paraffins are fed to said dehydrogenation catalyst.

57. The method of claim 1 wherein hydrogen and said paraffins are fed to said dehydrogenation catalyst at a molar ratio of from about 0.1 to about 20.

58. The method of claim 1 wherein hydrogen and said paraffins are fed to said dehydrogenation catalyst at a molar ratio of from about 1 to about 10.

59. The method of claim 1 wherein said dehydrogenation conditions comprise a residence time effective to maintain a conversion level of said isoparaffinic composition below about 50 mole%.

60. The method of claim 1 wherein said dehydrogenation conditions comprise a residence time effective to maintain a conversion level of said isoparaffinic composition of from about 5 to about 30 mole%.

61. The method of claim 1 wherein said dehydrogenation conditions comprising a residence time effective to maintain a conversion level of said isoparaffinic composition of from about 10 to about 20 mole%.

62. The method of claim 1 wherein said branched olefin composition comprises non-converted paraffins and said non-converted paraffins are separated from said branched olefin composition.

63. The method of claim 63 wherein said non-converted paraffins are recycled to said dehydrogenation catalyst.

64. The method of claim 63 wherein said nonconverted paraffins are separated from said branched olefin product by a procedure selected from the group consisting of extraction, extractive distillation, and absorption.

65. The method of claim 63 wherein said non-converted paraffins are separated from said branched olefin composition by absorption onto molecular sieves comprising a zeolite.

66. The method of claim 66 wherein said zeolites are selected from the group consisting of zeolite 4A, zeolite 5A, zeolite X, zeolite Y, and combinations thereof.

67. The method of claim 1 wherein  
at least 75%w of said branched olefin composition  
comprises olefins having a carbon number of from  
14 to 17; and  
said surfactant is a surfactant sulfate.

68. The method of claim 1 wherein  
at least 90%w of said branched olefin composition  
comprises olefins having a carbon number of from  
14 to 17; and  
said surfactant is a surfactant sulfates.

69. The method of claim 1 wherein said average number of branches is from 0.7 to 2.0.

70. The method of claim 1 wherein said average number of branches is from 0.7 to 1.5.

71. The method of claim 1 wherein said average number of branches is from 1.0 to 1.5.

72. The method of claim 1 wherein said number of quaternary aliphatic carbon atoms is 0.3% or less of the carbon atoms present in said branched olefins.

73. The method of claim 1 wherein at least 70%w of said branched olefin composition is said branched olefins.

74. The method of claim 1 wherein at least 90%w of said branched olefin composition is said branched olefins.

75. The method of claim 1 wherein said branched olefin composition comprises at most 10%w linear olefins.

76. The method of claim 1 wherein said branched olefin composition comprises at most 1%w linear olefins.

77. A process for preparing branched alcohol sulfates, comprising:

converting branched olefins into said branched alcohol sulfates, said branched olefins having been obtained by a process comprising;

subjecting a paraffinic wax to first conditions effective to hydrocrack and hydroisomerize said paraffinic wax and to produce an isoparaffinic composition comprising 0.5% or less quaternary aliphatic carbon atoms, said isoparaffinic composition comprising paraffins having a carbon number of from about 7 to about 35, at least a portion of said paraffins being branched paraffins comprising an average number of branches per paraffin molecule of at least 0.7 calculated over the total of branched paraffins and linear paraffins present, said branches comprising a first number of methyl branches and optionally a second number of ethyl branches;

exposing said isoparaffinic composition to a dehydrogenation catalyst in an amount and under dehydrogenation conditions effective to dehydrogenate said isoparaffinic composition and to produce a branched olefin composition comprising 0.5% or less quaternary aliphatic carbon atoms.

78. The process of claim 77 further comprising converting said branched olefins into branched alcohols and

converting said branched alcohols into said branched alcohol sulfates.

79. The process of claim 78 wherein said converting said branched olefins into branched alcohols comprises reacting said branched olefins with carbon monoxide and hydrogen in the presence of a hydroformylation catalyst.

80. The process of claim 78 wherein said converting said branched alcohols into said branched alcohol sulfates comprises contacting said branched alcohols with a sulfating reactant under sulfating conditions effective to convert said branched alcohols to said branched alcohol sulfates.

81. The process of claim 80 wherein said sulfating reactant is selected from the group consisting of oleum, sulfur trioxide ( $\text{SO}_3$ ), chlorosulfonic acid ( $\text{ClSO}_3\text{H}$ ), sulfamic acid ( $\text{NH}_2\text{SO}_3\text{H}$ ), and combinations thereof.

82. The process of claim 80 wherein said sulfating reactant is oleum.

83. The process of claim 80 wherein said sulfating reactant comprises from about 1 to about 30%w sulfur trioxide in sulfuric acid.

84. The process of claim 83 wherein said sulfur trioxide is present at from about 0.3 to about 1.3 moles per mole of branched alcohols.

85. The process of claim 83 wherein said sulfur trioxide is present at from about 0.4 to about 1.0 moles per mole of branched alcohols.

86. The process of claim 80 wherein said sulfating conditions comprise a temperature of from about 20 °C to about 70 °C.

87. The process of claim 80 wherein  
said sulfating reactant is sulfur trioxide; and  
said converting said branched alcohols into said  
branched alcohol sulfates comprises contacting

contacting said branched alcohol or an ethoxylate thereof with gaseous sulfur trioxide in a reaction zone of a falling film sulfator at a temperature of from about 20 °C to about 70 °C and at a pressure of from about 0.8 to about 1.2 bara to yield a sulfuric acid ester of said alcohol or said ethoxylate thereof.

88. The process of claim 87 further comprising neutralizing said sulfuric acid ester with a base to form sulfate salts of said sulfuric acid ester.

89. A composition comprising sulfates having the following chemical formula



wherein R is a branched primary alcohol having a carbon number in the range of from 8 to 36;

A is an alkylene oxide;

x is the average number of moieties A per moiety R and is in the range of from 0 to 15;

M is a cation selected from the group consisting of an alkali metal ion, an alkaline earth metal ion, an ammonium ion, and mixtures thereof; and

n is a number depending on the valency of the cation(s) M, such that the total electrical charge is zero;

wherein said sulfates comprise 2% or less quaternary aliphatic carbon atoms.

90. The composition of claim 89 wherein said carbon number is from about 11 to about 19.

91. The composition of claim 89 wherein said carbon number is from about 15 to about 18.

92. The composition of claim 89 wherein M is selected from the group consisting of  $NH_4^+$ , potassium, and magnesium.

93. The composition of claim 89 wherein said sulfates comprise alkali metal sulfates of branched primary alcohols having a carbon number of from about 11 to about 19.

94. The composition of claim 93 wherein said carbon number is from about 15 to about 18.

95. The composition of claim 93 further comprising a condensation product of said branched primary alcohols with an alkoxy- groups selected from the group consisting of ethylene oxide and 1,2-propylene oxide, said condensation product comprising from about 3 to about 12 ethoxy groups and comprising a ratio of ethoxy groups to 1,2-propoxy groups of from about 4 to about 12.

96. The composition of claim 89 comprising a detergent formulation.

97. A branched olefin composition comprising olefins having different, consecutive carbon numbers in the range of from 7 to 35, of which olefins at least a portion of the molecules is branched, the average number of branches per molecule being at least 0.7 and the branching comprising methyl and optionally ethyl branches, which branched olefin composition is obtainable by a process which comprises dehydrogenating an isoparaffinic composition which has been obtained by hydrocracking and hydroisomerization of a paraffinic wax, wherein said branched olefin composition comprises 0.5% or less quaternary aliphatic carbon atoms.

98. A process for preparing branched olefins which process comprises dehydrogenating an isoparaffinic composition over a suitable catalyst which isoparaffinic composition comprises paraffins having a carbon number in the range of from 7 to 35, of which paraffins at least a portion of the molecules is branched, the average number of branches per paraffin molecule being at least 0.7 and the branching comprising methyl and optionally ethyl branches, and which isoparaffinic composition has been obtained by

hydrocracking and hydroisomerization of a paraffinic wax, wherein said branched olefins comprise 0.5% or less quaternary aliphatic carbon atoms.

99. A process as claimed in claim 98 wherein the content of branched paraffins of the isoparaffinic composition is in the range of from 70 %w to 99.95 %w, relative to the weight of the isoparaffinic composition.

100. A process as claimed in claim 98 wherein the number of methyl branches present in the isoparaffinic composition is at least 20 % of the total number of branches.

101. A branched alcohol composition made by the process of claim 1, said process further comprising reacting said branched olefins with carbon monoxide and hydrogen in the presence of a suitable catalyst.

102. A surfactant made by the process of claim 1 selected from the group consisting of an anionic surfactant, a nonionic surfactant and a cationic surfactant.

103. An isoparaffinic composition comprising paraffins having different, consecutive carbon numbers in the range of from 7 to 35, of which paraffins at least a portion of the molecules is branched, the average number of branches per paraffin molecule being at least 1.5 and the branching comprising methyl and optionally ethyl branches, wherein said isoparaffinic composition comprises 0.5% or less quaternary aliphatic carbon atoms.

104. A branched olefin composition made by the process of claim 98.